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CLASSROOM LIGHTING.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

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DESCRIPTORS- *CLASSROOM ENVIRONMENT, *ILLUMINATION LEVELS, *LIGHTING, *TEACHER ROLE, *VISUAL PERCEPTION, MAINTENANCE, PHYSICAL HEALTH,

THE IMPORTANCE OF ILLUMINATION TO THE SCHOOL CHILD IS DISCUSSED. VISUAL EFFICIENCY HAS A MARKED EFFECT UPON MANY LEARNING SITUATIONS AND IT IS INFLUENCED BY A NUMBER OF FACTORS--(1) THE STAGE OF GROWTH AND DEVELOPMENT OF THE CHILD'S EYES, (2) THE PRESENCE OF EYE DEFECTS, (3) RELATIVE BRIGHTNESS OF OBJECT AND BACKGROUND (CONTRAST), (4) SIZE OF OBJECT, (5) DISTANCE OF THE OBJECT, (6) AMOUNT OF ILLUMINATION, AND (7) GLARE. ALSO INCLUDED ARE SECTIONS ON--(1) QUANTITY OF ILLUMINATION, (2) QUALITY OF ILLUMINATION AND BRIGHTNESS BALANCE, (3) REFLECTION FACTORS IN THE ENVIRONMENT, (4) NATURAL LIGHTING AND ITS CONTROL, (5) ARTIFICIAL LIGHTING AND ITS CONTROL, AND (6) MAINTENANCE. IN ADDITION THE ROLE OF THE TEACHER IN THE ILLUMINATION PROGRAM IS DEALT WITH IN TERMS OF HOW HE CAN IMPROVE SEEING CONDITIONS IN THE CLASSROOM. (RK)

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Classroom Lighting

EF 001 444

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS, INC.
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Cover photograph courtesy of the Illuminating Engineering Society

CLASSROOM LIGHTING

The Importance of Illumination to the School Child

The sense of sight is of vital importance in the education of a child. Yet all too often teachers take it for granted and appreciate its full significance only when it is suddenly lost or impaired. The process of seeing is indeed very complex involving, as it does, not only the eyes and the brain but indirectly all other parts of the body. Therefore factors which affect the seeing process adversely may also have a harmful effect upon the child's general well-being. Illumination is one of the factors of primary importance to good vision, for even perfect eyes cannot see in the absence of light. Since most of the close eye work now required of school children is performed in the indoor arena of the classroom, and since teachers are responsible for helping to maintain optimum health of all children in their care, it is imperative that every teacher understand the fundamental principles involved in control of the visual environment.

Many studies have indicated that proper lighting of a classroom can produce notable advantages, both educational and physical, namely: (1) greater desire to work and to concentrate on the tasks assigned; (2) less fatigue and its attendant effects (lack of interest, indolence, nervousness, poor achievement, bad posture); (3) greater comfort and contentment; (4) more cheerful environment conducive to better mental health; and (5) greater neatness and accuracy in work. Every effort should be made by teachers to obtain these advantages for all children.

The Meaning and Value of Good Illumination

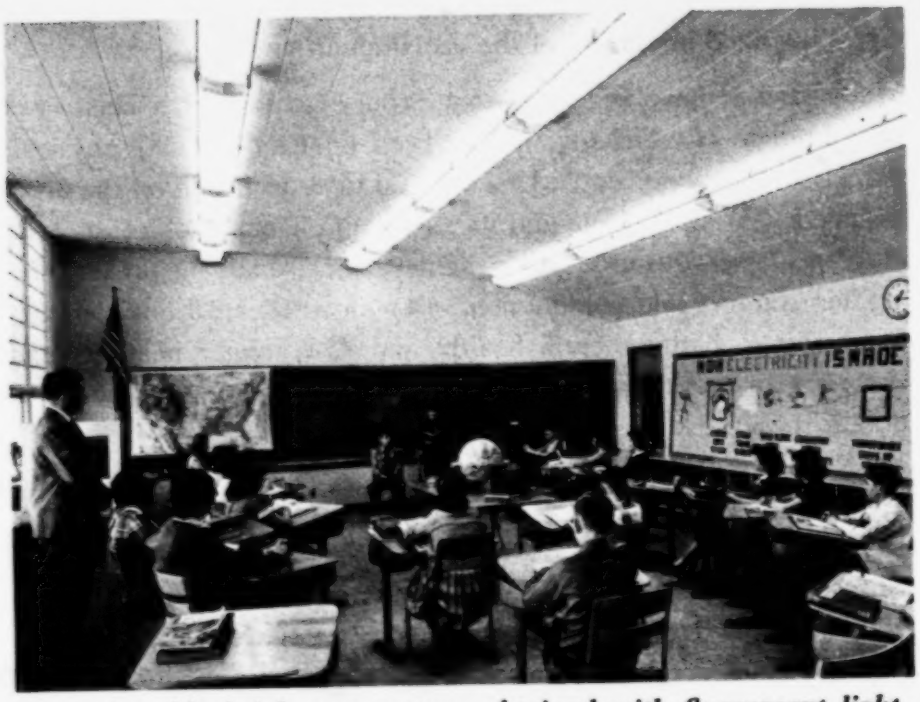
Until recently illumination was evaluated almost entirely in quantitative terms: How much light is there on the working surface? The emphasis now is on visual comfort and efficiency and hence embraces the whole visual environment. It attempts to answer the question: How well can we see?

Visual efficiency has a marked effect upon many learning situations and it is influenced by a number of factors.

1. The Stage of Growth and Development of the Child's Eyes—The eyes of many children in the primary grades have not yet reached their maximum size; hence they see objects at a distance better than those at close range. Yet they are expected to concentrate on printed matter and to learn to read. Adequate illumination of good quality will assist them in nearpoint work by reducing fatigue.

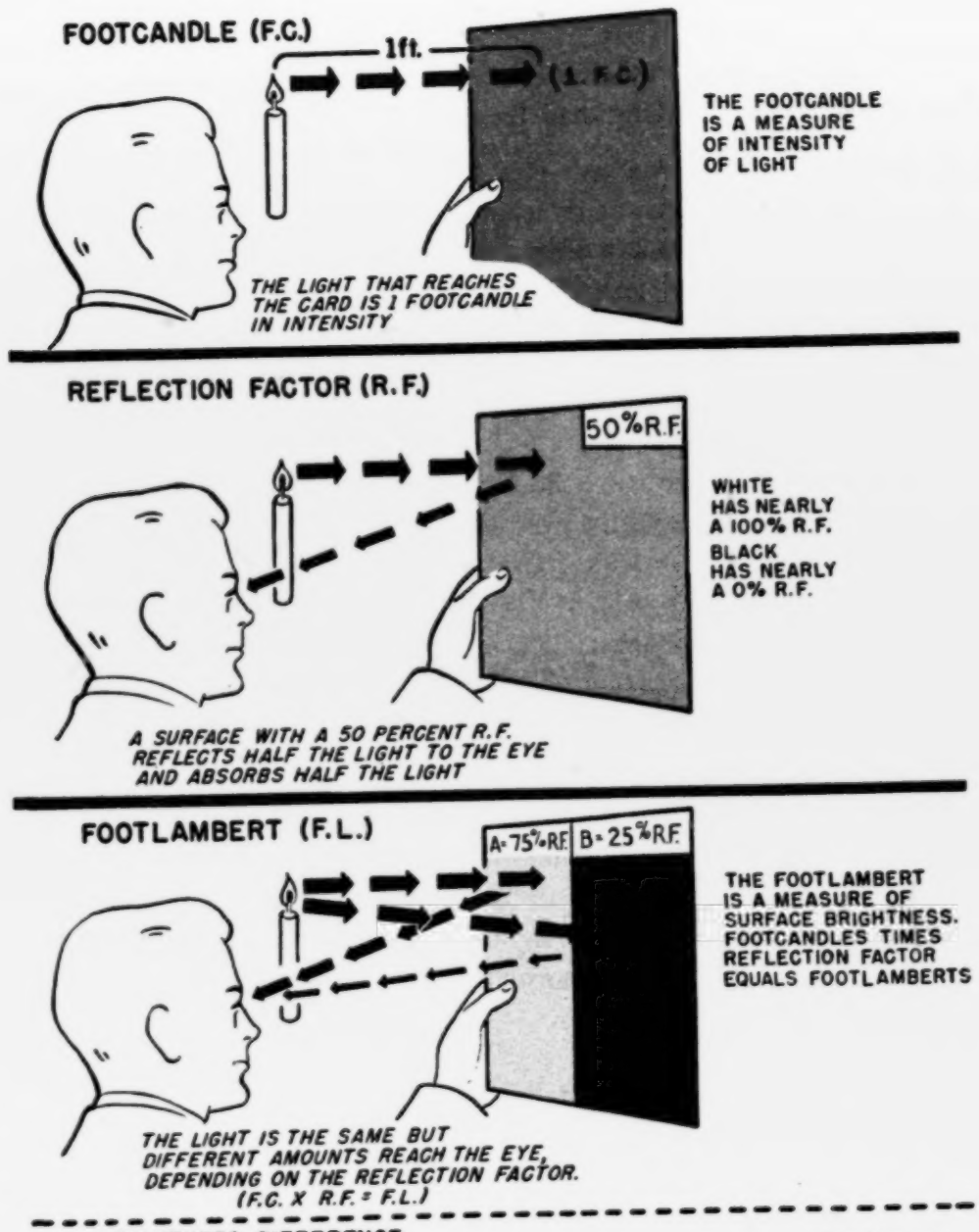
2. The Presence of Eye Defects—Children with certain eye defects, e.g., astigmatism, can see better when the lighting level is high. However, some eye defects such as albinism and certain types of cataract may require less than average amounts of light. The advice of the ophthalmologist should be sought in these cases.

3. Relative Brightness of Object and Background (Contrast)—Visibility can be improved by increasing the contrast between the object and its background. Select books with clear black print on dull white (or off-white) paper; use gray or blue-green chalkboards with soft white chalk.



A comfortable brightness pattern obtained with fluorescent lighting. Courtesy of Illuminating Engineering Society, New York, N.Y.

Diagram 1.—Language of Light


FOOTCANDLE (F.C.)
1ft.
(1 F.C.)
THE FOOTCANDLE IS A MEASURE OF INTENSITY OF LIGHT
THE LIGHT THAT REACHES THE CARD IS 1 FOOTCANDLE IN INTENSITY
REFLECTION FACTOR (R.F.)
50% R.F.
WHITE HAS NEARLY A 100% R.F.
BLACK HAS NEARLY A 0% R.F.
A SURFACE WITH A 50 PERCENT R.F. REFLECTS HALF THE LIGHT TO THE EYE AND ABSORBS HALF THE LIGHT
FOOTLAMBERT (F.L.)
A=75% R.F.
B=25% R.F.
THE FOOTLAMBERT IS A MEASURE OF SURFACE BRIGHTNESS. FOOTCANDLES TIMES REFLECTION FACTOR EQUALS FOOTLAMBERTS
THE LIGHT IS THE SAME BUT DIFFERENT AMOUNTS REACH THE EYE, DEPENDING ON THE REFLECTION FACTOR. (F.C. X R.F. = F.L.)
BRIGHTNESS DIFFERENCE
From the above sketch:
A = 3/4 of a FOOTLAMBERT
B = 1/4 of a FOOTLAMBERT
A is to B as 3 is to 1 Brightness difference is 3 to 1
Brightness difference can be measured by comparing footlamberts

• Reprinted from *American School Buildings*, through the courtesy of the American Association of School Administrators.

4. Size of the Object—As size increases, visibility increases up to a certain point. If there is need to read small print, visibility can be increased by increasing illumination.

5. Distance of the Object—Use of the eyes for distant vision is normally less fatiguing than for nearpoint (i.e., reading).

6. Amount of Illumination—Researchers have proved that the eye cannot obtain efficiency in accuracy and speed of seeing with less than 10 foot-candles of light (see Diagram 1) and that speed of vision at higher light levels is several times as great as at lower levels.

7. Glare—Glare has been defined as "the effect of brightnesses within the visual field sufficiently high to cause annoyance, discomfort or loss of visual performance."

Good illumination for a schoolroom must be concerned with both quantity and quality if the eyes are to see with best efficiency.

Quantity of Illumination

Adequate light is important to eye comfort and efficiency. Light increases the speed and accuracy of seeing and the ability of the eye to function under handicaps, such as the presence of eye defects or any difficult seeing tasks involving discrimination of fine detail. The eyes, after a period of adaptation, can function under extremes of high and dim light, but the power to discriminate fine details increases with the amount of light. The effort to function under dim light causes fatigue even to normal eyes. (See Table I)

Quality of Illumination and Brightness Balance

The purpose of light in a classroom is to produce a degree of brightness. Good seeing conditions involve brightness of the task itself, brightness of the immediate surroundings of the task (desk and table tops), and brightness of the entire peripheral field of vision (everything the eye sees in the field of view on all sides as well as up and down). Although the eye adjusts readily to changes in the quantity of light, it cannot adjust to excessive brightness differences which exist simultaneously in various parts of the visual field, thus causing glare.

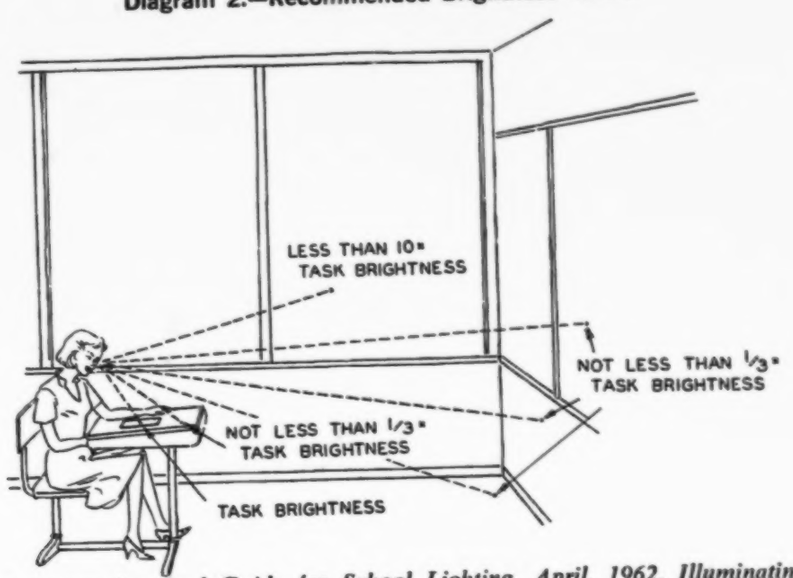
Table I—Levels of Illumination Currently Recommended for Classrooms*

Tasks	Minimum Foot-candles on Tasks
Reading printed material	30
Reading pencil writing	70
Spirit duplicated material	
Good	30
Poor	100
Drafting, benchwork	100
Lip reading, chalkboards, sewing	150

**I E S Lighting Handbook, Third Edition. Illuminating Engineering Society, 345 East 47th Street, New York, N.Y., 1959. p. 9-82.*

Schoolrooms often contain shiny and glossy surfaces which produce reflected glare: varnished furniture, glass doors in cabinets, glass-covered pictures on the walls, etc. Sometimes the lighting fixtures themselves will be so placed or so selected as to constitute a source of direct glare. To prevent glare, brightness differences or ratios must be kept within certain prescribed limits. (See Diagram 2)

Diagram 2.—Recommended Brightness Ratios



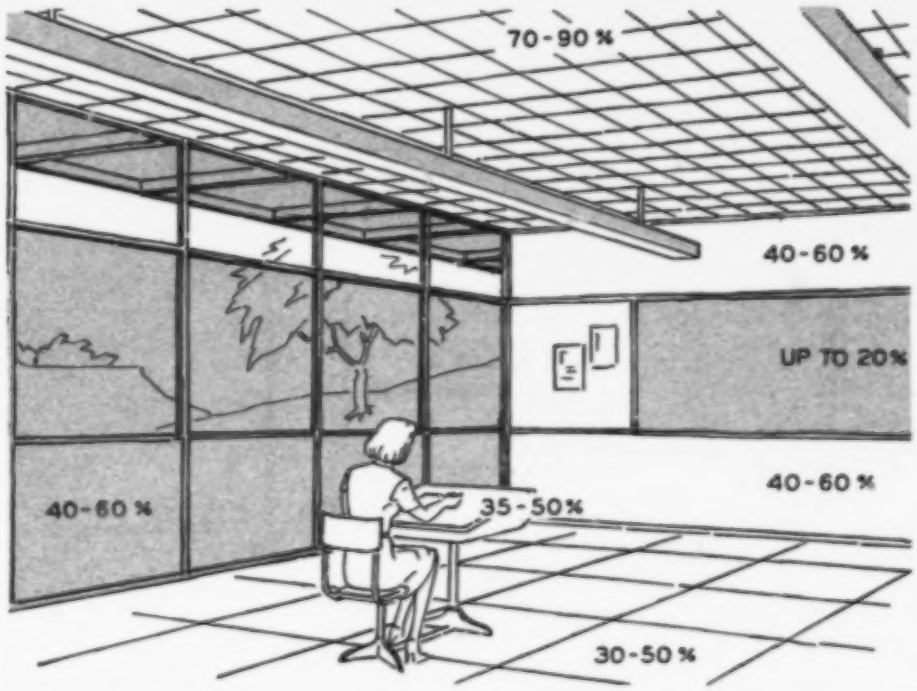
American Standard Guide for School Lighting, April, 1962. Illuminating Engineering Society, New York, N.Y.

To be of good quality light must also be well distributed throughout the classroom from all *overhead* directions. To avoid shadows on the working surface, right-handed children (when writing) should receive more light from over the left shoulder than from over the right. The reverse is true for left-handed pupils. However, if light is evenly distributed and diffused in all parts of a schoolroom, there will be no shadows and the brightness intensity will be the same in all directions.

Reflection Factors in the Environment

The brightness pattern in a schoolroom is a result not only of the amount of light and the manner of its distribution but also of the reflecting characteristics of the room surfaces and furniture. Some of the light falling upon a surface or object is absorbed and the rest is reflected. The amount reflected is expressed in terms of per cent and is called the reflection factor or reflectance (See Diagram 1).

Diagram 3.—Recommended Reflectances for Surfaces and Furnishings in the Classroom



American Standard Guide for School Lighting, April, 1962. Illuminating Engineering Society, New York, N.Y.

The lighter a color the higher its reflection factor. The amount of light in certain areas of a room can often be doubled merely by repainting or by changing the color. Covering chalkboards not being used with light-colored shades, tackboard or cork will increase light levels on the desks near the boards.

Eye hygiene calls for high reflection from all surfaces above eye level, so that the light striking them may be reflected downward onto the work. Surfaces below eye level should reflect slightly less light. Diagram 3 indicates desirable reflectances of various room surfaces.

Natural Lighting and Its Control

In accuracy and speed of vision as well as in sustained acuity the eye responds more favorably to daylight than to artificial light of the same intensity, but quality and quantity of daylight vary with geographic and climatic conditions.

In schoolrooms with windows on one side only (unilateral lighting), the desks farthest from the windows receive much less light than those close to the window side. If artificial light is available in adequate amounts and is properly used to supplement daylight illumination, the light on the inner row of desks may be kept at satisfactory levels. In classrooms lighted unilaterally, if the desks are parallel with the windows, many students will be subjected to glare, since the windows will be within their field of vision. On bright days, rays of light from the windows are stronger than rays being reflected from the printed page. Both types of rays will enter the eye with the results that (1) central vision needed for reading becomes less efficient since this is being controlled by the weaker rays; and (2) the brighter rays striking the surrounding visual field induce glare fatigue. Therefore the desks should be turned slightly away from the windows and toward the center of the room so that no window will appear ahead of the child's line of vision.

To obtain a more uniform distribution and diffusion of light than that afforded by unilateral lighting, many new types of construction

have been designed by architects. These involve bilateral lighting, with the added source preferably on the inner wall, the light from this being diffused from the ceiling onto the inner rows of desks.

No matter what method is used to provide natural lighting in a schoolroom, window shades of some kind will be necessary at certain times. Since the upper portion of the window is the most effective area in providing light for the darker inner side of the room, it should never be covered except to exclude direct rays of sun or excessive amounts of reflected brightness from snow or adjacent buildings. Therefore every window should have two shades mounted at the middle, one rolling up and the other down; or one mounted at the middle and rolling up and the other mounted at the bottom and rolling up. Adequate precaution should be taken to prevent streaks of light from entering between the rollers or at the sides. Shades should be of a light color to harmonize with the other surfaces and decorations and should be of such a texture as to diffuse sunlight well and not to crack.

In some parts of the country where sunlight is intense during many hours of the school day, venetian blinds have been used satisfactorily as shading devices; care must be taken in adjusting these.

Permanent vertical louvers set at nearly right angles to the glass may also be used in place of shades in some situations, while in others, fiberglass diffusing screens of 60 per cent transmission, hung at an angle of 45 degrees from the vertical, have been found effective in reducing excessive brightness.

From the teacher's standpoint the most important things to keep in mind regarding natural lighting arrangements are: (1) no child should sit facing a window or with a bright window area in his direct field of vision; (2) nothing opaque should be placed on window sills or pasted on the window panes to obstruct light; (3) the tops of the windows should be unshielded at all times except when the sun is shining directly through them.

Artificial Lighting and Its Control

All classrooms should be equipped with some form of artificial lighting for supplementing daylight on dark and cloudy days and

for furnishing illumination to parts of the room which receive insufficient natural light. In those buildings which are to be used for night classes, provision must be made for good illumination to satisfy both day and night conditions.

One sees equally well under the same illumination value from incandescent as from fluorescent lighting of comparable diffusion and directional quality. Therefore, either type may be used satisfactorily in the schoolroom if all other aspects of the visual environment have been properly considered. In either case, no bare or unshielded incandescent bulbs or fluorescent tubes should be exposed to view. Placement, size, shape, spacing and mounting problems are specific for each classroom and should be solved by a qualified illuminating engineer. All fixtures should be placed well above the normal line of vision and only against a light background.

Regardless of whether fluorescent or incandescent lighting is used, each row of lights should be on a separate switch.

Local lighting installations may be needed for chalkboards because board writing is more difficult to read from a distance and some children will be more than 20 feet from the board. Furthermore, the *vertical* illumination on the board surface is usually only about half that on the *horizontal* desk tops. The direction of this supplementary light must be very accurately controlled to prevent glare in the eyes of the teacher demonstrating at the chalkboard as well as in the eyes of the pupils.

Most partially seeing and deaf children require higher brightness levels: for the partially seeing, to compensate for their eye difficulties; for deaf children, to assist them in efficient seeing upon which they are dependent for most of their education. In both cases, the recommendation is for 150 foot-candles of good quality illumination.

All areas in which difficult or prolonged seeing tasks are required (art, sewing, and drafting rooms) should be provided with high levels of artificial illumination. Specialized shops, science rooms and laboratories, gymnasiums, auditoriums, and swimming pools will usually require unique lighting installations.

In lighting the classroom for television viewing, there are two important considerations: the quality of the TV picture and the visual

comfort in the room while the picture is being viewed. The room should not be darkened, but there should be no light falling on the TV screen either from direct light such as sunlight entering the room or from reflectance from bright objects such as lighting fixtures. One way this can be avoided is to use a hood over the TV screen to improve the picture contrast. To provide comfortable levels of light distribution it is also recommended that the brightness of the surroundings should not be less than one-third of the brightness of the TV screen. The set should be placed so that viewers do not face windows.

Well maintained lighting. Courtesy of Illuminating Engineering Society, New York, N.Y.

Maintenance

Unless the visual environment and the lighting installations are properly maintained, substantial loss of illumination will result. Blackened or old bulbs or tubes, dust and dirt on lighting fixtures, soiled walls and ceilings, dirty floors and furniture and windows,

all cause reduction in lighting levels. An adequate maintenance program calls for a well-planned schedule that includes the following: (1) frequent cleaning of lamps and fixtures; (2) constant attention to operation of lamps and tubes (blackened lamps should be discarded and flickering fluorescent tubes checked to determine the cause of flicker); (3) periodic washing, cleaning, and redecorating of walls, floors, ceilings, and furniture; (4) frequent cleaning of chalkboards; (5) regular window washing program; (6) inspection of shades and louvers; and (7) removal of all light obstructions such as plants, window decorations, and curtains.

Role of the Teacher in the Illumination Program

When the teacher understands the importance of eye health and the effect of illumination upon the eye comfort and efficiency of her pupils, she will be eager to cooperate in maintaining an optimum visual environment in the classroom at all times. The teacher is uniquely qualified to assist in this program and she can make a contribution that no other school employee is in a position to make. Every teacher can improve seeing conditions in her classroom by:

1. Keeping upper portions of windows unshaded except when the sun is shining directly on them
2. Drawing shades over the lower portions of the glass area only when necessary to diffuse direct sunlight or to reduce glare from snow, sky, or adjacent buildings
3. Checking illumination levels in all parts of the room periodically with a light meter
4. Making special seating arrangements for left-handed pupils so that light will fall over the right shoulder
5. Keeping window sills free of all obstructions to light
6. Arranging seats and desks so that no pupil will face a window or work in his own shadow
7. Cleaning chalkboards frequently
8. Eliminating books, charts, maps, etc., that are so soiled as to provide poor brightness contrast

9. Providing copyholders and easels to maintain good posture and optimum lighting for close eye tasks
10. Making all board writing large and clear and placing it in the line of vision of the pupils
11. Planning the daily program so as to alternate periods of close eye work with activities less demanding visually
12. Switching on artificial lights whenever brightness levels fall below standard in any part of the room
13. Standing and sitting in positions which direct pupils' vision away from the windows
14. Planning for periodic adjustments of seats and desks to provide for best use of available light
15. Placing pupils with eye difficulties in the best-lighted places from the standpoint of their specific defects
16. Allowing pupils to change their seats whenever they desire more light or less light
17. Selecting work places to make best use of available light
18. Covering chalkboards not being used with light tackboard or cork to conserve the available light
19. Covering glass doors on cabinets and removing pictures covered with glass
20. Selecting and using only those textbooks, maps, charts, posters, etc., that have non-gloss surfaces, appropriate type size, and desirable contrast
21. Noting when incandescent lamps or fluorescent tubes become blackened or defective and calling for correction from the custodian
22. Developing in the children a sense of responsibility for assisting in the maintenance of good seeing conditions.

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